CLAIMS

1. A sensing arrangement having a sensor device and amplifier circuitry, the sensor device being constructed and arranged to provide a sensor signal when it receives or one or more charged particles and/or one or more quanta of electromagnetic radiation, the amplifier circuitry having an input node and an output node, the sensor device being connected to said input node for supplying said signal thereto whereby the level at the output node changes, and further having feedback circuitry connecting said input node and said output node for feeding back a portion of the level at the output node for maintaining a first level at the output node in the absence of a said signal from said sensor device, the feedback device being responsive to the change in level of said output node to vary the effect of said feedback circuitry when said level changes to increase the loop gain of said amplifier circuitry.

2. A sensing arrangement according to claim 1, wherein the feedback circuitry comprises a dc path and capacitive path, and the capacitance of the capacitive path reduces substantially to zero when the level at the output node is close to a threshold level.

3. A sensing arrangement according to claim 1 or claim 2 wherein the feedback circuitry comprises a MOSFET, having a drain -source path connecting said input node and said output node, said MOSFET having a gate connected to a reference potential.

4. A sensing arrangement according to claim 3, wherein said amplifier circuitry is arranged to have an output node level which changes in response to

a said signal sufficiently to cause the drain current of the said MOSFET to fall to zero, whereby the amplifier circuitry operates in an open-loop condition.

5. A sensing arrangement according to claim 3 or 4, having an input current source constructed and arranged to apply a current to said input node of said amplifier, wherein said MOSFET is operable to provide a path from said input node to carry said current to said output node whereby said MOSFET is maintained in deep weak inversion.

6. A sensing arrangement according to claim 5 wherein the current source comprises a current mirror.

7. A sensing arrangement according to claim 3, 4, 5 or 6, having an output transistor having a gate connected to said output node for providing an output signal indicating detection of a said charged particle and/or electromagnetic radiation, wherein said reference voltage determines the level of said sensor signal required to provide said output signal to allow single particle detection.

8. A sensing arrangement according to claim 5 or 6, in which the input current source is constructed and arranged to be controllable to a value of substantially zero to allow integration by said amplifier of sensed charge of said sensor device signal with the amplifier in open-loop condition, wherein the amplifier has a source follower output for providing an analogue output.

9. A sensing arrangement having a sensor device and amplifier circuitry, the sensor device being constructed and arranged to provide a sensor signal when it receives or one or more charged particles and/or one or more quanta of

electromagnetic radiation, the amplifier circuitry having an input node and an output node, the sensor device being connected to said input node for supplying said signal thereto whereby the level at the input node changes and causes an output signal from said output node, the arrangement further comprising a current mirror connected to said input node and constructed and arranged to supply current thereto for restoring the level at the input node to a starting level.

10. A sensing arrangement according to any preceding claim integrated on a semiconductor substrate.

11. A sensing arrangement comprising a sensor device for detecting arrival of an incident quantum of electromagnetic radiation and/or charged particles, and an amplifier connected to the sensor for amplifying a signal from the sensor, wherein the sensor and the amplifier are fabricated on a common substrate, the arrangement being constructed and arranged to discriminate between the arrival of single or multiple incident quanta at the sensor device.

12. A sensing arrangement according to any preceding claim wherein the sensor device comprises one or more selected from the group comprising a p-n junction sensor, a p-n photodiode, an avalanche photodiode, a radiation sensor for detecting charged particles and/or X-ray photons, an amorphous Si:H PIN diode, and a high atomic number semiconductor PIN diode.

13. A sensing arrangement according to any preceding claim, wherein the sensing arrangement is a pixel cell.

14. A sensing arrangement according to any preceding claim further comprising a readout circuit comprising complementary metal oxide semiconductor (CMOS) circuitry for receiving the output of the sensor device and producing an output signal corresponding to said detection.

15. A sensing arrangement according to any preceding claim, wherein a quantum provides an input charge to the sensor device, wherein the input charge is around 10 to 15 e- at a reference current of around 10pA.

16. A sensing arrangement according to claim 7 or any claim dependent on claim 7, wherein the voltage potential is arranged to bias the output transistor in weak inversion at a drain current of few nanoamps.

17. A sensing arrangement according to claim 7 or any claim dependent on claim 7, wherein the drain current increase of the output transistor is 1000 times (3 current decades) its value between around 1nA to 1μA for an output voltage increase of the amplifier of about 250 mV.

18. A sensing arrangement according to any preceding claim, wherein an output voltage increase of about 250 mV is generated by an input charge of about 25 e^-.

19. A detection system comprising an array of sensing arrangements according to any preceding claim, comprising a readout circuit for receiving the output of the sensor devices and producing an output signal corresponding to said detection.

20. A macropixel comprising an array of sensing arrangements according to any preceding claim, wherein the outputs of said sensor devices are combined to give the effect of a larger pixel.

21. A macropixel according to claim 20 wherein the outputs of the sensor devices are connected to a bus.

22. A method of detecting the arrival of one or more charged particles and/or one or more quanta of electromagnetic radiation using a sensing circuit comprising a sensor device, and amplifier circuitry, wherein the sensor device is connected to an input node of the amplifier circuitry and is constructed and arranged to provide a signal when it receives said one or more charged particles and/or one or more quanta of electromagnetic radiation, the method comprising: feeding back a portion of an output voltage at an output node of said amplifier circuitry to said input node; amplifying the voltage at said input of said amplifier circuitry, whereby the voltage at the output node increases; and in response to said increase in voltage, reducing the portion of said output voltage that is fed back to increase the loop gain of said amplifier circuitry.

23. A method according to claim 22, further comprising decreasing a capacitance between said output node and said input node as the voltage at the output node increases.

24. A method according to claim 22 or 23, comprising reducing said feedback to zero whereby the amplifier circuitry operates in an open-loop condition.